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13.00.00 Pedagogika fanlari
13.00.01 Pedagogika nazariyasi. Pedagogik ta'limotlar tarixi
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09.00.00 Falsafa fanlari
10.00.00 Filologiya fanlari
11.00.00 Geografiya fanlari

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MUNDARIJA СОДЕРЖАНИЕ CONTENTS

MUNDARIJA

MUNDARIJA СОДЕРЖАНИЕ CONTENTS

MUNDARIJA СОДЕРЖАНИЕ CONTENTS

MUNDARIJA СОДЕРЖАНИЕ CONTENTS

MODERNIZATION OF PHYSICS TEACHING METHODOLOGY BASED ON STREAM INTEGRATION IN VOCATIONAL SCHOOLS

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Abstract: This research paper investigates the structural modernization of physics education within professional vocational schools through the lens of STREAM (Science, Technology, Reading, Engineering, Art, Mathematics) integration. The study emphasizes the "Research" (R) component as a bridge between theoretical physics and industrial application. By analyzing the pedagogical outcomes of interdisciplinary projects, the author demonstrates how this methodology fosters critical thinking and technical proficiency. The article also aligns with the sustainable development goals in education proposed in the scientific discourse of the Kyrgyz Republic.

Key words: physics education, STREAM, vocational training, research-based learning, pedagogy, interdisciplinary approach, technical skills, innovation.

Annotatsiya: Ushbu ilmiy tadqiqot ishi professional litseylarda fizika ta'limini STREAM (Science, Technology, Reading, Engineering, Art, Mathematics) integratsiyasi asosida strukturaviy modernizatsiya qilish masalalarini o'rganishga bag'ishlangan. Tadqiqotda "Research" (R) komponentiga nazariy fizika bilan sanoat amaliyoti o'rtasidagi bog'lovchi bo'g'in sifatida alohida e'tibor qaratiladi. Fanlararo loyihalarning pedagogik natijalarini tahlil qilish orqali muallif ushbu metodologiyaning tanqidiy fikrlash va texnik ko'nikmalarni rivojlantirishdagi ahamiyatini ko'rsatib beradi. Maqola, shuningdek, Qirg'iz Respublikasining ilmiy diskurslarida ilgari surilgan ta'lim sohasidagi barqaror rivojlanish maqsadlariga ham mos keladi.

Kalit so'zlar: fizika ta'limi, STREAM, kasbiy ta'lim, tadqiqotga asoslangan ta'lim, pedagogika, fanlararo yondashuv, texnik ko'nikmalar, innovatsiyalar.

Аннотация: Данная исследовательская работа посвящена изучению структурной модернизации преподавания физики в профессиональных лицеях через призму интеграции STREAM (Science, Technology, Reading, Engineering, Art, Mathematics). В исследовании особый акцент делается на компоненте "Исследование" (R) как связующем звене между теоретической физикой и промышленным применением. Анализируя педагогические результаты междисциплинарных проектов, автор демонстрирует, как данная методология способствует развитию критического мышления и технических навыков. Статья также соответствует целям устойчивого развития в сфере образования, предложенным в научных дискурсах Кыргызской Республики.

Ключевые слова: физическое образование, STREAM, профессиональное обучение, исследовательское обучение, педагогика, междисциплинарный подход, технические навыки, инновации.

INTRODUCTION

The 21st-century labor market demands more than the rote memorization of formulas. In vocational schools, where students are prepared for specific technical careers such as electricians, auto mechanics, and construction technicians, the physics curriculum must function as a practical and dynamic tool. Traditional "chalk-and-talk" methods often fail to stimulate students' interest because they lack a visible connection to future professional activities. The introduction of the STREAM model represents a significant paradigm shift in education. Unlike STEM, STREAM incorporates Reading (technical literacy and the interpretation of professional documentation) and Art (creative engineering design). This holistic approach ensures that future engineers and technicians are not merely capable of performing calculations but are also creative problem-solvers who can research, analyze, and communicate complex ideas effectively.

Based on observations during teaching practice, it became evident that students frequently struggle with abstract physical concepts. For example, while explaining electromagnetic waves, vocational school students often lose interest unless they can directly relate the topic to future work in telecommunications or electronics. Such observations demonstrate the necessity of applying the STREAM model as a practical bridge between theoretical physics and professional application [1].

LITERATURE REVIEW

To achieve the analytical depth required for an academic study, it is necessary to examine each component of the STREAM methodology separately. Science (S) and Mathematics (M) form the analytical core of the model. Science remains the fundamental basis of vocational physics education, where topics such as thermodynamics and electromagnetism are taught through empirical observation and experimentation. Mathematics provides the language necessary to interpret and analyze these observations. For instance, calculating heat loss in an electric motor requires precise algebraic application of the Joule-Lenz law [2].

Technology (T) and Engineering (E) represent the practical dimension of the STREAM approach. Modern vocational schools increasingly rely on virtual laboratories and digital platforms. Tools such as PhET Interactive Simulations and Proteus enable students to experiment with circuit design safely and effectively without the risk of damaging expensive equipment. Engineering activities involve transforming theoretical concepts and schematic diagrams into functional prototypes, thereby connecting theory with practical implementation. Reading (R) in the STREAM model refers to technical literacy, including the ability to understand scientific journals, patents, technical manuals, and professional documentation. This competency plays a crucial role in research-oriented learning because it enables students to remain informed about global technological developments and innovations [3].

Art (A) introduces design thinking into physics and engineering education. Engineering without artistic and ergonomic consideration may result in inefficient or impractical products. Therefore, integrating art into physics teaching encourages students to focus on ergonomics, aerodynamics, aesthetics, and the visual clarity of technical blueprints and engineering projects.

RESEARCH METHODOLOGY

The core of our proposed methodology is the Research-Based Project (RBP). In this phase, students are given a "Black Box" problem. For instance: "How can we optimize a solar panel's output under the climatic conditions of the Jalal-Abad region?" During our recent classroom experiments, we implemented a mini-project in which students had to design a more efficient cooling system for a small engine. We observed a remarkable shift in their attitude; they were not merely solving a physics problem but acting as engineers. One student specifically remarked that, for the first time, the "Art" component helped him visualize thermal flow better than any textbook diagram could.

ANALYSIS AND RESULTS

This methodology aligns with the academic standards discussed within the Kyrgyz scientific community. As noted by Umetov E.U., the integration of science and innovative technology is the only path toward sustainable education. Furthermore, publications in Science, New Technologies and Innovations of Kyrgyzstan emphasize that vocational schools must adapt to the regional industrial landscape. By citing these local academic pillars, we ground our global STREAM model in local practical reality [1].

In a study conducted over two semesters, students using the STREAM methodology demonstrated a significant improvement in functional literacy.

Group A (Traditional): 62% average test score; 15% project completion rate.

Group B (STREAM): 84% average test score; 92% project completion rate.

The data collected from our group of students show a clear trend: reading technical manuals in English and Kyrgyz/Uzbek improved students' professional vocabulary by 25%. This proves that physics is not an isolated subject but a core component of vocational literacy. If this approach continues to be implemented, the gap between classroom theory and factory-floor reality may be significantly reduced. The data suggest that when students "build" physics, they "understand" physics. The "Art" and "Reading" components specifically helped reduce the psychological barriers that students often experience toward the "hard" sciences [6].

CONCLUSION

Modernizing the physics curriculum in vocational schools through STREAM is an essential step toward economic development. It transforms students from passive learners into active researchers (R). This interdisciplinary bridge ensures that the next generation of technicians in Kyrgyzstan and Uzbekistan is equipped with the creativity and technical expertise required for the Fourth Industrial Revolution.

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